



Presented to the **Civil Engineering Department**
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In partial fulfillment
of the course
Engineering Mechanics Dynamics (ENGMEC2)
(EH)

Problem Set 1

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Group 8

No. _____

Date _____

1. $x = 8t^3 - 8 + 30 \sin(\pi t)$ mm

$$v = \frac{dx}{dt}$$

$$v = 24t^2 + 30\pi \cos(\pi t)$$

$$a = \frac{dv}{dt}$$

$$a = 48t - 30\pi^2 \sin(\pi t)$$

When $t = 5$ [calculators deg. $\rightarrow$ rad.]

$$x = 8(5)^3 - 8 + 30 \sin(\pi 5) = 992 \text{ mm}$$

$$v = 24(5)^2 + 30\pi \cos(\pi 5) = 505.75 \text{ mm/s}$$

$$a = 48(5) - 30\pi^2 \sin(\pi 5) = 240 \text{ mm/s}^2$$

$$a_A = -15 \text{ ft/s}^2 \quad a_B = -12 \text{ ft/s}^2$$

2.



$$V_0 = 60 \text{ ft/s (Both)}$$

Find: min dist. d to avoid collision

Sol. $V_f = V_0 + a t$

$$V_{fA} = 60 - 15(t_A - 0.75)$$

$$V_{fB} = 60 - 12(t_B)$$

$$\Delta x = V_0 t + \frac{1}{2} a t^2$$

$$x_B = (60)t_B + \frac{1}{2}(-12)(t_B)^2$$

$$x_B = 60t_B - 6t_B^2 \rightarrow 0$$

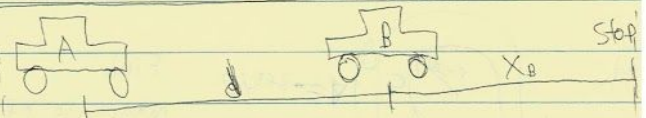
$$x_A = x_{A1} + x_{A2} \rightarrow ③$$

$$x_{A1} = V_0 t_{A1} + \frac{1}{2} a t_{A1}^2$$

$$x_{A1} = 60(0.75) = 45 \text{ ft.} \rightarrow ④$$

$$x_{A2} = V_0 t_{A2} + \frac{1}{2} a t_{A2}^2 \quad \text{since } t_A = t_B \text{ \& } t_A = t_{A1} + t_{A2}$$

$$x_{A2} = 60(3.75 - 0.75) + \frac{1}{2}(-15)[3.75 - 0.75]^2 = 112.5 \text{ ft.} \rightarrow ⑤$$



$$t_{A1} = 0.75 \text{ sec}$$

$$V = 60 \text{ ft/s}$$

$$t_{A2} = ?$$

$$t_A = t_{A1} + t_{A2}$$

$$x_B =$$

$$x_A =$$

$$V_{fA} = V_{fB} ; t_A = t_B$$

$$60 - 15(t_A - 0.75) = 60 - 12(t_B)$$

$$t = 3.75 \text{ sec.} \rightarrow ②$$

use ② in ④ $x_B = 140.625$

use ④ and ⑤ in ③

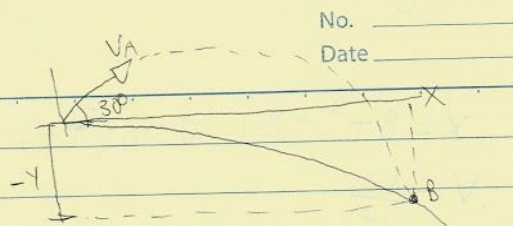
$$x_A = 157.5 \text{ ft.}$$

$$d = x_A - x_B = 157.5 - 140.625$$

$$d = 16.875 \text{ ft.}$$

3. $\theta_A = 30^\circ$; $X = 15 \text{ ft}$; $Y = -9 \text{ ft}$

Find: V_A (KKE); V_B (land)



Sol.

$$t_x = t_y$$

$$X_A = X_0 + (V_A \cos 30^\circ) t$$

$$15 = 0 + (V_A \cos 30^\circ) t_x$$

$$\frac{15}{V_A \cos 30^\circ} = t_x \rightarrow \text{①}$$

$$t_x = 1.05 \text{ s (using } V_A \text{)}$$

$$Y - Y_0 = V_y t_y - \frac{1}{2} g t_y^2$$

$$-9 - 0 = (V_A \sin 30^\circ) t_y - \frac{1}{2} (32.2 \text{ ft/s}^2) t_y^2$$

use ①

$$-9 = (V_A \sin 30^\circ) \left[\frac{15}{V_A \cos 30^\circ} \right] - \frac{1}{2} (32.2) \left[\frac{15}{V_A \cos 30^\circ} \right]^2$$

$$V_A = 16.54 \text{ ft/s}$$

$$V_{Bx} = V_{Ax}$$

$$V_{Bx} = V_A \cos 30^\circ = 14.32 \text{ ft/s}$$

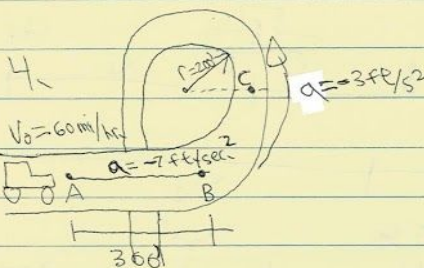
$$V_B = \sqrt{V_{Bx}^2 + V_{By}^2}$$

$$V_{By} = V_{y0} - g t$$

$$= (V_A \sin 30^\circ) - (32.2)(1.05)$$

$$V_{By} = -25.54 \text{ ft/s}$$

$$V_B = 29.28 \text{ ft/s}$$



Find:

magnitude of total acc.:

a. Before B

b. After B

c. @ C

Sol.

$$P.A.: V_A = 60 \text{ mi/hr} \times \frac{5280 \text{ ft}}{1 \text{ mi}} \times \frac{1 \text{ hr}}{3600 \text{ s}} = 88 \text{ ft/s}$$

$$a_A = a_0$$

$$a_{AB} = -7 \text{ ft/s}^2$$

$$b. V_B^2 = V_A^2 + 2a(X - X_A)$$

$$V_B^2 = (88 \text{ ft/s})^2 + 2(-7)(300)$$

$$V_B = 59.53 \text{ ft/s}$$

$$a = \frac{V^2}{r} = \frac{59.53^2}{200} = 17.72 \text{ ft/s}^2$$

normal

tangential

$$a_t = -3 \text{ ft/s}^2$$

$$a_B = \sqrt{a_n^2 + a_t^2}$$

$$c. V_C = ?$$

$$a_t = \frac{V_C^2 - V_B^2}{2r}$$

$$-3 = \frac{V_C^2 - (59.53)^2}{2(200)}$$

$$V_C = 40.73 \text{ ft/s}$$

$$a_n = \frac{V_C^2}{r} = \frac{(40.73)^2}{200} = 8.24 \text{ ft/s}^2$$

$$a = \sqrt{a_n^2 + a_t^2}$$

$$a = \sqrt{(8.24)^2 + (-3)^2}$$

$$a_C = 8.82 \text{ ft/s}^2$$

$$a_B = 17.97 \text{ ft/s}^2$$